CLOUDS AND THE EARTH'S RADIANT ENERGY SYSTEM (CERES)

CERES VALIDATION PLAN

GRIDDING AND SPATIAL AVERAGING (SUBSYSTEM 6.0)

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6.0 SPATIAL AVERAGING

6.1 INTRODUCTION

6.1.1 Measurement and Science Objectives

The major data products for climate research from CERES are the gridded results. The gridded results are intended to be the regional average of the quantities. The Release 1 algorithm for CERES will be the Alley Oop algorithm which was used for ERBE, i.e. the average of the pixels whose centroid lies in the region. There is very little information in the extant literature dealing with the accuracy of the gridding and regional averaging operation, even for ERBE. A simulation study was published by Stowe et al. (1993). The Constrained Least Square (CLS) method (Hazra et al., 1993, 1996) has been proposed for computation of the regional averages for data taken in the cross-track scan mode, and the Best Regional Integral Estimator (BRIE) has been proposed for the computation of regional averages from the azimuthally rotating (biaxial) mode. Although simulation studies have a role and should be made, analyses of the various methods are needed in order to understand the nature of the regional averaging process. The basis of such an analysis is given by Smith et al. (1983). The combination of analysis and simulation is needed for the validation of the regional averaging process. Finally, the software must be validated to ensure that it is operating correctly. The software will be validated by processing simulated data. All validation work will be done prior to the first CERES instrument flight. No post-launch activity is planned.

6.1.2 Missions

The CERES instruments will be flown on multiple satellites, which include TRMM, EOS AM-1, and EOS PM-1 to provide the diurnal sampling necessary to obtain accurate monthly averages of the TOA radiative parameters.

6.1.3 Science Data Products

All atmospheric and radiant flux quantities are to be regionally averaged to produce gridded products as listed in chapter 6 of the CERES Algorithm Theoretical Basis Document.

6.2 VALIDATION CRITERION

6.2.1 Overall approach

Analyses will be made of the Alley Oop, CLS, and BRIE methods to define the errors of each method. Simulation studies will also be performed to provide examples of the problem.

It may be suggested that one approach to validation of regional averaging would be to compare results from two different spacecraft, i.e. ERBE scanner results from ERBS and NOAA 9. The differences in regional averages from such intercomparisons would be largely due to bidirectional reflectance functions. Thus, this approach is not recommended. Likewise, processing real satellite data will validate that the software operates, but not that it gives the correct answers. Testing of the software with simulated data is important for this reason.

6.2.2 Sampling Requirements

N/A

6.2.3 Measures of success

One result of the analyses will be a curve of regional averaging error as a function of view zenith angle to the center of the region for each algorithm. This curve will define the limits of the applicability of the algorithm. For example, with ERBE, we compute the regional average for a region which has only one pixel whose centroid lies within it, at a view zenith angle of 70 degrees. Is this a valid result or should we not include this region because the standard deviation of the error is too large? This question has never been addressed.

6.3 PRELAUNCH ALGORITHM TEST/DEVELOPMENT

6.3.1 Field experiments and studies

N/A

6.3.2 Operational surface networks

N/A

6.3.3 Existing satellite data

The analysis requires the spatial spectra of the output products, i.e. the outgoing longwave and reflected shortwave fluxes. These spectra can be developed from ERBE and AVHRR data for a wide range of spatial wavelengths which is needed for the analysis. The simulations can best be done with geosynchronous satellite data at a scale which is small compared to the CERES pixel size. All of these data are in hand.

6.4 POST-LAUNCH ACTIVITIES

6.4.1 Planned field activities and studies

N/A

6.4.2 New EOS-targeted coordinated field campaigns

N/A

6.4.3 Needs for other satellite data

N/A

6.4.4 Measurement needs (in situ) at calibration/validation sites

N/A

6.4.5 Needs for instrument development

N/A

6.4.6 Geometric registration site

N/A

6.4.7 Intercomparisons

N/A

6.5 IMPLEMENTATION OF VALIDATION RESULTS IN PRODUCTION OF DATA

6.5.1 Approach

The major question to be answered by the analyses is what are the errors of the various algorithms. The CLS algorithm and BRIE algorithms will be implemented only if they are demonstrated to have a clear superiority in accuracy over the Alley Oop algorithm. Secondly, the limits of each algorithm will be defined. For example, in the Alley Oop algorithm as presently applied, a regional average will be computed on the basis of a single measurement. As a result of the analyses, a minimum number of measurements may be required for a regional average to be computed if the Alley Oop algorithm is selected.

6.5.2 Role of EOSDIS

The software which will be delivered to EOSDIS will have the results of the validation studies incorporated.

6.5.3 Plans for archival of validation data

Papers will be published describing the validation studies, in the open literature as much as possible and in project documents (such as this) to the necessary extent.

6.6 SUMMARY

Validation studies for the regional averaging computation will be completed prior to launch. The results will guide the selection of regional averaging algorithms to be implemented in the CERES software. Errors due to the regional averaging computation will be defined.

REFERENCES

Hazra, R., G. L. Smith, and S. K. Park, 1996: Accurate reconstruction of Earth's radiation field from Earth Radiation Budget Experiment (ERBE) measurements. Submitted to *IEEE Trans actions on Geoscience and Remote Sensing*.

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